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Spectral Characterization of Modern Spacecraft Materials

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ABSTRACT

One of the observational parameters of interest in ground-based optical measurements is ascertaining material properties using broadband filter photometry and spectroscopy for orbiting targets. Broadband photometry can provide reflectance measurements that can aid in color-color indices and assess if objects can be classified into families or taxonomies. However, these reflectance properties can vary due to aspect angle, phase angle, and general degradation of the target's exterior material. Spectral characterization can aid in material characterization utilizing known absorption bands and spectra signatures, but these signatures are affected by the same conditions described for remote observations. When utilizing ground-based measurements, it is well understood that material characterization is subject to variability due to space weathering and/or other external events (i.e., collision or explosion). The focus of this study is on space weathering effects on spacecraft materials in low Earth orbit.

To better assess how materials are affected by the harsh space environment, specifically modern materials, a collection of materials was analyzed in both its pristine condition and after electron bombardment. This sample collection is part of an upcoming mission with the Materials International Space Station Experiment Flight Facility (MISSE-FF) that will be launched in 2022. These laboratory analyses on the samples will provide a ground-truth to compare with the *in-situ* collected data. The data will also be stored in the NASA Johnson Space Center's Spacecraft Materials Spectral Database that is available to U. S. citizens and maintained by the Orbital Debris Program Office.

The following paper provides an overview of the materials investigated, laboratory and database overview, and spectral results for both pristine and post-electron exposed conditions. The spectral signature data highlights which materials are stable, or remain relatively unchanged, and which materials vary significantly due to exposure and material configuration (variations due to rotation of the sample on a flat surface). Initial results on changes in spectral directional reflectance of the materials as a function of incident illumination direction are also presented. This data also will benefit the space situational awareness community with spectral characterization of novel materials that can support their respective optical measurements focused on material identification.